

CHROMOSOME NUMBERS OF *LINUM* FROM THE SOUTHERN UNITED STATES AND MEXICO

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About 150 species of *Linum* are recognized throughout a predominantly tropical and subtropical distribution. In North America, Small (1907) included 48 species in *Cathartolinum* and only 5 in *Linum*, although Winkler (1931) transferred all species to *Linum*. A total of 36 species have been studied cytologically of which 12 are found in North America.

MATERIALS AND METHODS.—Plants were collected in the field in Alabama, Floriad, Georgia, Mississippi, New Mexico, Texas, and Mexico. Immature flower buds were fixed following the procedure of Lewis and Oliver (1961) from which PMCs are more rarely somatic cells were examined. Occasionally, seeds obtained from commercial sources and herbarium sheets were cultured on a medium developed by Lewis and Elvin-Lewis (1961). Seeds were first soaked in water for 1-2 days and 1 day after germination mitosis was observed in root tip cells. All chromosome drawings were made with the aid of a camera lucida at X2300. Vouchers for all collections are filed in the Southern Methodist University Herbarium and duplicates have been distributed elsewhere. We appreciate the verifications of some collections by Dr. C. Marvin Rogers, Wayne State University. Field work was in part aided by a grant from the National Science Foundation, G-9800.

RESULTS AND DISCUSSION.—Fourteen species and varieties have been studied from 31 localities as listed in Table 1. Three species, *L. grandiflorum* ($n=8$, Fig. 1), *L. perenne* L. ($2n=18$), and *L. usitatissimum* ($n=15$, Fig. 15), are introduced into North America and our results verify those counts by previous workers. Of the remaining species, all indigenous to this continent, the numbers for *L. lewisii* ($n=9$, Fig. 2) and *L. rigidum* ($n=15$, Fig. 15) verify those of Kikuchi (1926, 1929), Dillman (1933), and Ray (1944). However, Ray (1944) reported *L. medium* as $n=15$, but from 22 plants collected in Florida, Mississippi, and Texas, only $n=18$ (Fig. 8-9) and $2n=36$ were found. From plants collected in North Carolina, Ray also reported *L. virginianum* with $n=15$, but from Georgia we found 2 plants with $n=18$ (Fig. 11). Unfortunately Ray does not appear to have preserved voucher specimens so that it is not possible to check his determinations. The first chromosome numbers are reported for *L. arenicola* ($n=18$, Fig. 4), *L. floridanum* var. *chrysocarpum* ($n=18$, Fig. 5), *L. greggii* ($n=18$, Fig. 6-7), *L. imbricatum* ($n=15$, Fig. 12), and *L. pratense* ($n=9$, Fig. 3).



1



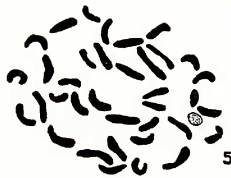
2



3



4



5



6



7



8

Although meiosis was generally found to be regular, a somewhat lower chiasmata frequency than is normal often resulted in incomplete bivalent formation. Consequently the chromosome numbers of PMCs at diakinesis (Fig. 8) and prometaphase (Fig. 12) were usually obscure and difficult to determine.

The North American species of *Linum* were grouped by Winkler (1931) into two sections, *Linum* (*Eulinum*) and *Cathartolinum*. The latter, considered by Small (1907) of generic rank, includes a majority of the North American species and was divided by Small into numerous sections. Those species having styles united one-half or more, large yellow petals, alternate leaves, and, so far as known, a chromosome number of $x=15$, form a natural group in *Linum* which Small recognized by his sections *Rigida*, *Multicaulia*, and possibly *Sulcata* under *Cathartolinum*. Thus LINUM, section MULTICAULIA (Small) Osborne, comb. nov., based on *Cathartolinum*, section *Multicaulia* Small, N. Am. Fl. 25:71, 1907, is proposed to include *L. imbricatum* (type species) and *L. rigidum*. Additional research may prove that other species particularly those from the sections *Rigida* and *Sulcata* may be included in this section.

REFERENCES

- DILLMAN, A. C. 1933. Chromosome numbers in flax (*Linum*). *Science* 78 (2027): 409.
- KIKUCHI, M. 1926. Studies on the difference of chromosome numbers in *Linum* species. *Jour. Soc. Agric. and For. (Sapporo)*. 81: 26-37.
- . 1929. Cytological studies of the genus *Linum*. *Jap. Jour. Genet.* 4: 202-212.
- LEWIS, W. H. and M. ELVIN-LEWIS. 1961. Medium for growing small rabiaceous seeds from herbarium material. *Castanea* 26: 146-155.
- and R. L. OLIVER. 1961. Cytogeography and phylogeny of the North American species of *Verbena*. *Amer. Jour. Bot.* 48: 638-643.
- RAY, C. JR. 1944. Cytological studies on the flax genus, *Linum*. *Amer. Jour. Bot.* 31:241-248.
- SMALL, J. K. 1907. *Linaceae*, in N. Amer. Fl. 25: 67-87.
- WINKLER, H. 1931. *Linaceae*, in A. Engler and K. Prantl, *Die Nat. Pflanzenfam.* 19a: 82-120.

Figs. 1-15. Chromosomes of *Linum* drawn with the aid of a camera lucida originally at X 2300 reduced by 21% in reproduction. Fig. 1. *L. grandiflorum*, $n = 8$, Osborne 70. Fig. 2. *L. lewissii*, $n = 9$, Osborne 78. Fig. 3. *L. pratense*, $n = 9$, Osborne 47. Fig. 4. *L. arenicola*, $n = 18$, Osborne 64. Fig. 5. *L. floridanum* var. *chrysocarpum*, $2n = 36$, Osborne 69. Fig. 6. *L. greggii*, $n = 18$ (anaphase II with two poles), Lewis 5743. Fig. 7. *L. greggii*, $n = 18$, Lewis 5752.



9



10



11



12



13



14



15

Table 1. CHROMOSOME NUMBERS FOR 13 SPECIES OF LINUM

Taxon	<i>n</i>	<i>2n</i>	Voucher
Section <i>Linum</i>			
<i>L. grandiflorum</i> Desf.	8	..	TEXAS. Harrison Co., Karnack (cultivated), Osborne 70 (4).*
<i>L. lewisii</i> Pursh	9	..	TEXAS. Howard Co., 9.5 miles W of Big Spring on Hwy. 80, Osborne 78 (3).
<i>L. perenne</i> L.	..	18	Rowe's Seed (2).
<i>L. pratense</i> (Norton) Small	9	..	TEXAS. Dallas Co., Kiest Park, Dallas, Osborne 47 (2), 51 (4); Hill Co., 8.7 miles N of Hillsboro, Oliver 284 (2); Somervell Co., 9.4 miles N of Brazos River on Hwy. 50, Osborne 50 (4).
<i>L. usitatissimum</i> L.	15	..	TEXAS. Harrison Co., Karnack (cultivated), Osborne 80 (4).
Section <i>Cathartolinum</i>			
<i>L. arenicola</i> (Small) Winkler	18	..	FLORIDA. Monroe Co., Big Pine Key, Osborne 65 (2), Park Key, Osborne 64 (3).
<i>L. floridanum</i> (Planchon) Trelease var. <i>chrysocarpum</i> Rogers	18	36	MISSISSIPPI. Hancock Co., 6.2 miles ENE of Pearl River on Hwy. 90, Osborne 69 (2).
<i>L. greggii</i> (Engelm.) Small	18	..	MEXICO. COAHUILA. 3.1 miles N of Los Llanos, Lewis 5743 (2). NUEVO LEON. 11 miles E of junction of Hwys. 57 and 60, Lewis 5752 (5).

Fig. 8. *L. medium* var. *texanum*, *n* = 18, Osborne 54. Fig. 9. *L. medium* var. *texanum*, *n* = 18, Osborne 55. Fig. 10. *L. schiedeanum*, *n* = 18, Osborne 75. Fig. 11. *L. virginianum*, *n* = 18, Osborne 56. Fig. 12. *L. imbricatum*, *n* = 15, Lewis 5588. Fig. 13. *L. rigidum* var. *berlandieri*, *n* = 15, Oliver 285. Fig. 14. *L. rigidum* var. *rigidum*, *n* = 15 (anaphase II with two poles), Lewis 5590. Fig. 15. *L. usitatissimum*, *n* = 15, Osborne 80.

- L. medium* (Planchon) 18 36 FLORIDA. Collier Co., 7.1 miles E of Naples, Osborne 63 (2); Sarasota Co., 1 mile W of junction of Hwys. 41 and 777, Osborne 61 (2). MISSISSIPPI. Hancock Co., 0.5 miles W of St. Louis Bay on Hwy. 90 Osborne 68 (2). TEXAS. Hardin Co., Kountze Fire Lookout Tower, Lewis 5627 (1); Marion Co., Jefferson, Osborne 57 (3), Lake of the Pines, nr Jefferson, Osborne 55 (6); Nacogdoches Co., Stephen F. Austin Experimental Forest, Osborne 53 (4), 54 (2).
- L. schiedeana* S. & C. 18 36 TEXAS. Brewster Co., Bib Bend National Park, Chisos Mountains, Osborne 73 (2), 74 (2), 75 (5), 76 (2). MEXICO. COAHUILA. 3.1 miles N of Los Llanos, Lewis 5730 (1).
- L. virginianum* L. 18 .. GEORGIA. Pike Co., 0.5 miles N of Pike-Upson Co. line and Hwy. 19, Osborne 56 (2).
- Section *Multicaulia*
- L. imbricatum* (Raf.)
Shinners 15 .. TEXAS. San Patricio Co., 5 miles SE of Mathis, Lewis 5588 (4).
- L. rigidum* Pursh var.
rigidum 15 30 TEXAS. Bee Co., 0.9 miles N of Pettus, Osborne 33 (2); San Patricio Co., Port Aransas, Lewis 5590 (3).
- L. rigidum* Pursh var.
berlandieri (Hook.)
T. & G. 15 .. TEXAS. Bee Co., 0.5 miles N of Tuleta, Osborne 32 (2); Hill Co., 8.7 miles NE of Hillsboro, Oliver 285 (3).

* Number of plants examined.